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## Effect of Hand and Pillow Methods of Incisional Splinting for Postoperative Deep Breathing and Coughing on Vital Capacity and Inspiratory Pressure in Cholecystectomized Patients

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EFFECT OF HAND AND PILLOW METHODS OF INCISIONAL  
SPLINTING FOR POSTOPERATIVE DEEP BREATHING AND  
COUGHING ON VITAL CAPACITY AND INSPIRATORY  
PRESSURE IN CHOLECYSTECTOMIZED PATIENTS

by

Kay Etta Fraulini

A Thesis Submitted to the Faculty of the Graduate School  
of Loyola University of Chicago in Partial Fulfillment  
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Master of Science in Nursing

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## VITA

The author, Kay Etta Fraulini, is the daughter of Leno Fraulini and Leona (Upchurch) Fraulini. She was born June 1, 1946 in Benton, Illinois.

Her elementary education was obtained in the public schools of Chicago, Illinois, and secondary education at Lake View High School, Chicago, where she graduated in January, 1964.

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She worked as a professional nurse between 1968 and 1979 in Illinois and California. Her area of interest and specialty was the Recovery Room and in 1978, she was elected president of the Illinois Society of Recovery Room nurses.

In June, 1979, she entered the master of science in nursing program at Loyola University of Chicago and in September, 1979, was granted an assistantship in nursing. In January, 1981, she was awarded the Master of Science in Nursing.

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## CHAPTER I

### OVERVIEW OF THE PROBLEM

#### Introduction

A nurse frequently encounters the problem of producing effective deep breathing and coughing in the post-surgical patient. Deep breathing and coughing are well documented aspects of an intelligent program for the management of the surgical patient during the postoperative period (Dripps, 1941). In 1941, Dripps and Waters challenged the nurse to consider the "stir-up" regimen her responsibility to the surgical patient. The regimen consists of three simple yet fundamental precepts: (1) the patient must be turned (2) the patient must cough and (3) the patient must inflate his lungs adequately with deep breaths. They also recommended that the incision be supported by manual pressure over the surgical dressing which will ease the discomfort to a considerable degree (Dripps & Waters, 1941).

Nursing literature suggests that applying pressure to the incision by placing a pillow over the patient's incision while he/she coughs is one way of decreasing incisional pain. Some patients find that bath blankets, bath towels, or most preferably, the direct placement of hands

is more useful in decreasing incisional pain while coughing. Whereas the pillow seems to absorb and disseminate the applied pressure, use of the hands seems to concentrate controlled pressure at the incisional site and is an effective means of achieving some control over the pain associated with coughing (Jacox, 1977).

There is no dearth of nursing studies on the "stir-up" regimen (Healy, 1968; Lindeman and VanAernam, 1971; Wallis, 1971; Shelter, 1972; Carrieri, 1975; Archuleta, Plummer, & Hopkins, 1977; and Alvares, 1978). Previous studies have been concerned with various preoperative teaching programs as they relate to postoperative ventilatory capacity, length of hospitalization, etc. None of these studies have been concerned with the mechanics of the deep breathing and coughing exercise. Specifically they did not investigate supporting or splinting the incision as it relates to the effect of deep breathing and coughing (ventilatory capacity).

#### Statement of the Problem and Hypothesis

The research question investigated in this study is: Do hand and pillow methods of incisional splinting for postoperative deep breathing and coughing differ in their effect on vital capacity and inspiratory pressure in cholecystectomized patients?

The research hypothesis is: Hand and pillow

methods of incisional splinting for postoperative deep breathing and coughing will not differ significantly in their effect on vital capacity and inspiratory pressure in cholecystectomized patients as measured by the Wright respirometer and the inspiratory force meter. Level of significance was set at .05.

#### Purpose of Study

The purpose of this study was to determine if a particular incisional splinting method utilized in the "stir-up" regime for surgical patients contributed to more effective deep breathing and coughing.

#### Scope and Limitations

The surgical patients studied represented a selected sample of 40 adult males and females. Only patients having elective cholecystectomy, a general anesthetic, and no history of chronic obstructive lung disease were included in this study. The patients were obtained at a large community hospital.

There was no attempt at ascertaining the influence of the investigator's presence on the patient's ability to deep breathe or the influence of the investigator's presence on the nursing staff.

#### Need and Significance of the Study to Nursing

Several factors indicated a need for this study:

1. There is a need to determine effectiveness of "stir-up" regimen in the postsurgical patient.
2. There is a need to examine the content of "stir-up" regimen as it is currently taught.
3. There is a need to determine if splinting the incision enhances the effect of deep breathing and coughing ("stir-up"), and if so, if one method produces a greater effect than another.

As a result of the above, the determination of the most effective regimen could have the potential of influencing both the education of nurses and patient recovery. That is, significantly positive results could then be added to the material which is taught preoperative patients, the goal being decreased incidence of postoperative pulmonary complications.

### Definitions

Hand splinting method is the patient placing both hands (the part of the upper limb distal to the forearm; the carpus, metacarpus, and fingers together) firmly over the abdominal incision.

Pillow splinting method is the patient placing a pillow (a cloth bag filled with feathers, down, sponge rubber or plastic fiber) over the abdominal incision.

Coughing is forced expiration in which a forceful contraction of the abdominal muscles pushes the abdominal

viscera against the diaphragm, thereby decreasing the thoractic volume suddenly and causing a rapid expulsion of air and/or sputum from the lungs.

Deep breathing is flattening of the diaphragm during inspiration with a resulting enlargement of the upper abdomen as the air rushes in.

Wright respirometer--spirometry is the measurement of the breathing capacity of the lungs. The Wright consists of a vane connected to a series of gears such that gas flowing through the body of the instrument rotates the vane and registers a volume.

Vital capacity is the largest volume measured on complete expiration after the deepest inspiration without forced or rapid effort.

Inspiratory force meter is the pressure gauge from an anesthesia machine (aneroid pressure gauge) connected to a mouthpiece. The gauge will record the negative pressure generated by the inspiration.

Inspiratory pressure is the expansion of the chest enough to produce a negative alveolar pressure and stimulate a deep breath.

## CHAPTER II

### REVIEW OF LITERATURE AND THEORETICAL RATIONALE

A summary of the literature relevant to this study is presented. The discussion includes "stir-up" regimen, nursing studies, respiratory physiology, and respiratory pathophysiologic changes postoperatively.

#### "Stir-up" Regimen

The "stir-up" routine has been discussed in the nursing literature since 1941 (Dripps, 1941). This routine requires the patient to take deep breaths, cough, and move around in bed postoperatively. The "stir-up" regimen and its effect on postoperative recovery has been well documented.

#### Nursing Studies

In 1968, Healy reported a study of preoperative teaching of deep breathing, coughing and bed exercises. The research question investigated was: Does preoperative instruction really make much difference in a patient's recovery? The subjects included 321 individuals admitted for elective surgery over a four month period. Data showed that 135 subjects in the experimental group went home 3-4

days prior to the expected day of discharge; only three of the patients in the control group were discharged prior to the expected date. There were three complications in the experimental group and sixteen in the control group. No statistical analysis was reported. This study cannot be considered a valid investigation of the effectiveness of planned and unplanned preoperative teaching for several reasons: (1) there was no direct measure of postoperative ventilatory function, and (2) data were not tested for significance.

Lindeman and VanAernam (1971) studied the effects of structured and unstructured preoperative teaching with the presurgical patient. The research was a comparative investigation of the effects of structured and unstructured preoperative teaching of deep breathing, coughing and bed exercises upon postoperative ventilatory function, length of hospital stay and postoperative need for analgesics. A static group pretest-posttest design was used. All surgical patients 15 years of age and older, admitted for elective surgery (other than EENT) with a general anesthetic, not on IPPB therapy, and able to comprehend instructions for the ventilatory function tests from May 24-June 18, 1970 served as subjects for the control group and received unstructured preoperative teaching. All such surgical patients admitted from November 1-November 27, 1970 served as subjects for the experimental group and received structured preoperative



teaching. There were 135 subjects in the control group and 126 subjects in the experimental group.

Preoperative teaching was done by registered nurses assigned to the surgical and pediatric units. Unstructured preoperative teaching referred to the nurse teaching what, when, and how she intuitively felt was adequate and correct. Structured preoperative teaching referred to the implementation of an approach standardized for content and method. This method was implemented after a descriptive effective stir-up regime procedure was written, and an intensive and extensive staff development program was conducted for all nursing personnel.

Tests of ventilatory function were administered preoperatively and 24 hours postoperatively. A t test of significance was applied to the mean difference scores for maximum expiratory flow rate, vital capacity, and one second forced expiratory volume. A t test was also applied to the data for mean length of hospital stay and mean number of analgesics administered postoperatively. The data supported the following: (1) the ability of subjects to deep breathe and cough postoperatively was significantly ( $p < .05$ ) improved by the structured preoperative teaching method; (2) the mean length of hospital stay was significantly ( $p < .05$ ) reduced by the implementation of the structured peroperative teaching method; and (3) there was

no differential effect ( $p > .05$ ) upon postoperative need for analgesia.

Initial studies by Lindeman and VanAernam (1971) and Lindeman (1972) found structured teaching associated with improved pulmonary function. More recent studies evaluating the effectiveness of preoperative intensive teaching have been discouraging and somewhat contradictory. They have addressed the question of whether teaching programs make a difference in postoperative pulmonary status and whether group teaching is as effective as individualized instruction (Risser, 1980).

Carrieri (1975) in her study of twenty-two patients, asked the question: Are there differences in postoperative ventilatory capacity (measured by lung volume, flow rate, gas exchange, and pulmonary shunting) between upper abdominal surgical patients who experience a teaching program that emphasizes deep breathing and coughing, and those who receive the nursing approach currently used? No significant ( $p > .05$ ) differences were found between the two groups when the data for each day were analyzed. However, the change in the forced midexpiratory flow rate from the preoperative day to the third postoperative day significantly ( $p < .05$ ) decreased in the control group compared to the group receiving the teaching program. Thus, these data indicate that the teaching program may have decreased the incidence of small airway (2 mm or less) obstruction. The

finding of a lower mean forced maximum midexpiratory flow rate in the control group in the presence of a mean forced expiratory volume for one second that was within normal range suggests obstruction limited to the smaller airways.

Archuleta, Plummer, and Hopkins (1977) used a staff development model designed around a training model with a consultation role delineated by project staff. The approach was designed through content developed for the retaining component. The content covered four areas: principles of teaching and learning, patient education, cultural implications, and respiratory care. The 265 patients in the unstructured teaching experimental group were from 11 participating hospitals. There was no statistically significant difference between the unstructured and structured groups on any of the five dependent variables, including three postoperative ventilatory function test scores: forced vital capacity; maximum midexpiratory flow rate; and forced expiratory volume one second, and the length of hospital stay or number of postoperative analgesics.

Prior studies have not dealt specifically with use of applied pressure over the incisional site, and this is considered inherent to the success of the regimen (Dripps, 1941). In this study, two methods of incisional splinting (1) the patient's hands placed over the abdominal incision

and (2) the patient placing a pillow over the abdominal incision were tested.

In 1968, Fraulini and Serowka studied the use of various splinting techniques in postoperative coughing. Using a sample of ten patients, male and female, 30-60 years old, with abdominal incisions, four methods of incisional splinting (1) no support (2) pillow (3) the patient using his hands, and (4) a binder were tried by each patient. Expiratory pressures were then measured with a mercury manometer designed by the researchers. Patients were also asked three questions: (1) which method would you like to use in future coughing; (2) which method do you feel assisted you to cough most effectively; and (3) which method caused you the least amount of pain? Results of manometer readings indicated highest scores were obtained either with no support or the binder. Overall, men scored higher than women. Dividing the sample by sex, highest expiratory pressure scores were obtained by the women when they used the pillow and by the men when they had no support. Below the mean age of 47 (4 patients, 3 of whom were women), the highest scores were obtained with the pillow, and above mean age (6 men) no support scored highest. In answer to all three questions, 40 percent chose the binder, 40 percent were neutral, and 20 percent chose the pillow. However, due to the small sample size, it is difficult to

draw conclusions from this study as to which method is most effective.

### Respiratory Physiology

Implicit in the understanding of applied incisional pressure or splinting (as part of the "stir-up" regimen) is knowledge of respiratory physiology. The respiratory system consists essentially of two parts, a gas-exchanging organ, the lung, and a pump to pump gas in and out of the gas-exchanging part, consisting of the respiratory muscles and chest wall (Derenne, 1978). Attention will be focused on the muscles that move the respiratory pump, because these muscles form an organ system that is just as vital as the heart and that can fail in much the same manner and for much the same reasons (Derenne, 1978). The lungs can be expanded and contracted by (1) downward and upward movement of the diaphragm to lengthen or shorten the chest cavity and (2) elevation and depression of the ribs to increase and decrease the anteroposterior diameter of the chest cavity.

Normal inspiration is caused principally by contraction of the diaphragm. This muscle is bell shaped so that contraction of any of its muscle fibers pulls it downward to cause inspiration. Three different groups of muscles cause inspiration by elevating the entire chest cage. The sternocleidomastoid muscles lift upward on the

sternum, the anterior serrati lift many of the ribs, and the scaleni lift the first two ribs. Since the anterior margins of all of the upper ribs are connected to the sternum, lifting one portion of the anterior chest cage lifts it all.

Ordinarily, expiration is an entirely passive process; that is, when the diaphragm relaxes, the elastic structures of the lung, chest cage, and abdomen, as well as the tone of the abdominal muscles, force the diaphragm upward. However, if forceful expiration is required (cough), the diaphragm can also be pushed upward powerfully by active contraction of the abdominal muscles against the abdominal contents. Thus, all the abdominal muscles combined together represent the major muscles of expiration. To cause expiration, the abdominal recti, in addition to helping to compress the abdominal contents upward against the diaphragm, also pull downward on the lower ribs, thereby decreasing the anteroposterior diameter of the chest. Thus, these muscles act as muscles of expiration both by depressing the rib cage and by compressing the abdominal contents upward. The external and internal intercostals are also important muscles of respiration despite their seemingly small size. The ribs during expiration are angled downward and the external intercostals are stretched in a forward and downward direction. As they contract, they pull the upper ribs forward in relation

to the lower ribs, and this causes leverage on the ribs to raise them upward. Conversely, in the inspiratory position, the internal intercostals are stretched, and their contraction pulls the upper ribs backward in relation to the lower ribs. This action causes leverage in the opposite direction and lowers the chest cage (Guyton, 1976).

The mechanics of respiration were especially important to this study because the focus was a mechanical procedure (deep breath and cough) and ways to improve the mechanics. Coughing and deep breathing (as measured by vital capacity using the Wright respirometer and inspiratory pressure using the inspiratory force meter) were identified by the researcher as the dependent variable in this study.

A cough can be defined in the following steps: First, about 2.5 liters of air is inspired. Second, the epiglottis closes, and the vocal cords shut tightly to entrap the air within the lungs. Third, the abdominal muscles contract forcefully, pushing against the diaphragm while other expiratory muscles, such as the internal intercostals, also contract forcefully. Consequently, the pressure in the lungs rises to as high as 100 or more mm. Hg. Fourth, the vocal cords and epiglottis suddenly open widely so that air under pressure in the lungs explodes outward. Furthermore, and most importantly, the strong compression of the lungs also collapses the bronchi and

trachea (the noncartilaginous part of the trachea invaginating inward) so that the exploding air actually passes through bronchial and tracheal slits. The rapidly moving air usually carries with it any foreign matter that is present in the bronchi or trachea (Guyton, 1976).

Postoperative patients, for a number of reasons, encounter great difficulty in effectively deep breathing and coughing. The independent variable in this study, splinting method (two levels--hands and pillow), were used as possible aids (based on mechanical respiratory physiology) in supporting or bracing the abdominal muscles.

#### Respiratory Pathophysiologic Changes Postoperatively

A brief overview of postoperative pulmonary pathophysiologic changes would include: abnormalities due to the composite events to which patients are exposed in the perioperative period including the surgical procedure itself; postoperative medications, specifically analgesics; and immobilization in the supine position. There are four areas on which these factors have some impact. First of all, lung volume is affected such that total lung capacity and each of its subdivisions decrease after abdominal surgery. This decrease is greater for upper than lower abdominal incisions. Secondly, the pattern of ventilation is affected. Within 24 hours after surgery, there is an approximate 29 percent decrease in tidal volume, a 26 per-



cent increase in respiratory rate, possible closure of airways in dependent lung zones (Mead & Collier, 1959), decreased compliance and absence of sigh (Egbert & Bendixen, 1964). Thirdly, gas exchange is altered such that there is increased intrapulmonary shunting. This effect suggests the presence of what may be referred to as "dispersed absorption collapse" or diffuse collapse of terminal lung units (Prys-Roberts, 1967). Finally, the defense mechanisms of the lung are impaired. There is decreased clearance of inhaled particles postoperatively since coughing is inhibited (Ross, 1955). This impairment is compounded by the fact that normal ciliary function is decreased (Kilburn, 1968). And, the clearance of microbial agents is decreased by arterial hypoxemia, one of the pulmonary changes that may develop postoperatively (Harris, 1975).

Abdominal and thoracic surgical intervention results in a transient acute restrictive pulmonary abnormality that primarily affects vital capacity (Shapiro, 1979). A decrease in total lung capacity or an increase in residual volume and, thus, a decrease in vital capacity is suggestive of respiratory muscle weakness (Derenne, 1978). The resulting limitation in ventilatory reserves is reasonably predictable while the resulting hypoxemia is readily responsive to moderate levels (30-40 percent) of oxygen therapy. The predictable postoperative restriction in total lung capacity is believed secondary to the limitation

of diaphragm and chest wall muscular activity. In other words, the thorax is limiting the inflation capability of reasonably unaltered lungs (Shapiro, 1979). This theory supports the need to focus attention on the mechanical aspects of postoperative deep breathing and coughing, and the possible significance of muscular support.

Hansen, Drablos, and Steinert (1977), in a study of 40 patients who underwent elective cholecystectomy, found forced vital capacity and forced expiratory volume one second markedly reduced from preoperative values on the first postoperative day, and then gradually increased to near preoperative values after one week. Arterial hydrogen ion concentration and carbon dioxide partial pressure showed no definite changes during the postoperative course.

The effectiveness of three current regimes of preoperative respiratory care in reducing postoperative respiratory complications following herniorrhaphy was studied prospectively (Wheatley, Hardy & Barter, 1977). No smoking for five days plus intensive physiotherapy, five days no smoking, and routine hospital admission two days preoperatively were the regimes. No statistical difference between the groups for pulmonary complications was noted.

Several recent studies have examined the role of pulmonary screening tests in the perioperative period (Yoshida, 1977; Levy, Rutherford, & Shepard, 1979; and Peters, 1979). Findings suggest that these tests can be

used to evaluate the risk of pulmonary complications developing in the postoperative period. Spirometry was shown to be equally as useful as chest x-ray in improving the accuracy and efficiency of screening procedures (Levy et al., 1979).

Peters (1979) examined the effects of gravity and has shown that immobilization of surgical patients can result in localized pulmonary edema if a portion of the lung is kept far enough below the left atrium to raise capillary hydrostatic pressure above the critical pressure. He concludes that one of the most important conservative treatments will be a return to concern about turning patients to make gravity an ally rather than an enemy.

Another variable that has been considered in the incidence of postoperative pulmonary complications is type of incision. Greenall, Evans and Pollock (1980) in a series of 579 patients undergoing major laparotomy compared the direction of incision (midline or transverse/oblique muscle-cutting). In no stratum did the direction of incision have any significant effect. Lindell and Hedenstierna (1976) found in a study of 44 patients undergoing cholecystectomy that the muscle splitting (no transection of the abdominal muscles) incision significantly improves postoperative ventilation efficiency compared to other incisions.

Deep breathing devices were investigated by

Lederer, Van de Water, and Indech (1980) and Lyager et al. (1979). Lederer et al., compared the use of three types of deep breathing devices in patients undergoing upper-abdominal operations. Seventy-nine patients were divided into three groups, each receiving preoperative bedside testing of pulmonary function and instruction in the use of one of three randomly assigned deep-breathing devices thought to be representative of those currently available (Triflo II, Bartlett-Edwards Incentive Spirometer, or Spiro-care). Repeat testing and instruction were provided daily during each of the first five postoperative days. There were few statistically significant differences in pulmonary function, vital signs, and white blood cell count, and no difference in length of postoperative stay. No device was uniformly acceptable to patients, and none was used as frequently as recommended. When left at the bedside with only one daily reinforcement of instructions, the three devices showed no clinically important differences. Lyager et al. (1979) in a controlled clinical investigation of the pre and postoperative condition of the lungs, were unable to show any beneficial effect of the Bartlett-Edwards Incentive Spirometer. Shapiro (1979) concludes that incentive spirometry may prove useful but above all the patient must be encouraged to frequently cough and deep breathe.

## CHAPTER III

### METHODOLOGY

#### Setting of the Study

This study was conducted on two surgical units at a large Midwestern community hospital from July, 1980 through mid-November, 1980. Written permission to perform the study was obtained from the Chairman, Department of Anesthesiology and the individual surgeons. Following the procedure established by the Clinical Research Committee of the community hospital and the Institutional Review Board of Loyola University of Chicago, informed consent to participate in the study was obtained from each patient.

#### Research Design

A pretest-posttest static group design was used. This design was selected to avoid contamination likely to occur if collection of control and experimental data is done concurrently. The design is diagrammed as follows:

S   O   O.....  
          S   O   X<sub>1</sub>   O.....  
                          S   O   X<sub>2</sub>   O

The "S" connotes the static or intact group; in this study the group consisted of all the adults undergoing chole-

cystectomy who met the identified criteria and volunteered to participate. The design consisted of three groups, one control and two experimental. The  $X_1$  refers to the experimental group using the pillow splinting method and the  $X_2$  refers to the experimental group using their hands as a splinting method. The first "O" in each group refers to the pretest which is ventilatory function as measured by vital capacity and inspiratory pressure. The second "O" refers to the posttest postoperatively. The test was done on the first and third days postoperatively and day of discharge.

Data were collected on the control group first. These patients received no instruction from the investigator other than a visit the night before surgery to obtain baseline vital capacity and inspiratory pressure readings, explain the purpose of the study and present the patient with a consent form (see Appendix). On the first postoperative day, the researcher again visited the patient, asked him to do whatever deep breathing and coughing he had been instructed to do (by the nurses on the unit), and vital capacity (using the Wright respirometer) and inspiratory pressure readings (using the inspiratory force meter) were measured. The same procedure was repeated on the third postoperative day and the day of discharge.

Data on the two experimental groups were obtained in the same way. The night before surgery Group B was requested by the researcher to use a pillow when they did any deep breathing and coughing postoperatively and spirometric readings were done with pillow in place. Group C was requested to use their hands (see Appendix). All data and measurements of vital capacity and inspiratory pressure were obtained by the investigator.

### Sample Selection

The sample included 40 male and female adult patients admitted for elective cholecystectomy between July, 1980 through mid-November, 1980. All patients that met the stated criteria were first assigned to Group A, the control group, until the quota of 15 was reached. Then 15 patients meeting the criteria were assigned to Group B. Group C consisted of 10 patients who met the criteria. Patients with documented abnormal pulmonary function studies were excluded since patients with abnormal studies have a 23:1 incidence of pulmonary complications (Shapiro, 1979). The variables of weight, gender, smoking history, type and length of general anesthesia were not controlled but were compared and analyzed.

### Criteria for Sample Selection

1. Males and females admitted for cholecystectomy.
2. Adults--21 years and older
3. Non-emergency surgery only
4. Having a general anesthetic
5. Able to cooperate for the tests of ventilatory function.
6. Having no history of chronic obstructive lung disease.

### Instruments

Evaluation of two incisional splinting methods used in this study (pillow and patient's hands) were based upon changes in vital capacity and inspiratory pressure measurements. It was decided to use vital capacity as a parameter of lung expansion, since this measurement best indicates reserve volume for deep breathing and coughing (Bendixen, 1965). The normal adult vital capacity ranges between 55 and 85 ml/kg. of normal body weight (Shapiro, 1979). Inspiratory pressure, as a second measurement of the patient's ability to do the work of breathing, was also used. The more negative the inspiratory pressure, the greater the patient's ability to inhale (Adams, 1979). A patient has to have a minimum inspiratory pressure of -20 cm H<sub>2</sub>O to cough effectively and prevent atelectasis (-25 to -30 cm H<sub>2</sub>O is more desirable) (Adams, 1979).



Measurements of vital capacity were obtained using the same Wright respirometer on all patients and inspiratory pressure using the same inspiratory force meter.

### Validity and Reliability

The Wright respirometer (Ohio Medical Products, Madison, Wisc.) is a miniature air turbine with moving parts of very low inertia. The revolutions of the rotor are recorded by means of a gear train and dial of the type used in wrist watches. The instrument indicates directly on the dial the number of liters of gas. The accuracy of the volumes are  $\pm 2$  percent at 16 liters/minute and 5 to 10 percent at 60.00 liters/minute with continuous flow. Compared with a spirometer, the respirometer was found to indicate a tidal volume which, at a minute volume above 3.7 liters, lay between the volume actually recorded at ambient temperature and pressure (saturated) and the same volume corrected to body temperature (Nunn and Egi-Ashi, 1962).

Validity of the Wright respirometer was established by comparison of its stroke volume with those obtained on the MDS Hand Calibrator (a calibrated 3 liter metal syringe) used in the pulmonary function laboratory of the hospital in which this study was undertaken. The stroke volume and FRC volume equalled 2.8 Atmospheres at Standard Temperature and Pressure. Calibration was done at 25°C., relative

humidity of 61 percent, syringe volume 2.8, K value 1.089 and an estimated volume of 3.07. Results showed a significantly ( $p < .05$ ) higher reading of the Wright respirometer; however, the extremely low variability of the Wright instrument suggests that the observed difference might well be considered a constant error in calibration.

Muscle fibers of the diaphragm contract to pull it downward and respiratory muscles of the chest wall lift the ribs upward to expand the chest cavity. Intra-alveolar pressure becomes slightly negative in relation to atmospheric pressure, and air flows into the lungs (Adams, 1979). An OEM Medical Inc. (Edison, N.J.) pressure gauge from an anesthesia machine was used to measure negative inspiratory pressure. The gauge was calibrated in mm Hg. 0-60 vacuum and 0-60 pressure. Readings obtained on the OEM gauge were compared with the Ohio Medical Products intermittent suction unit (mm Hg), a wall-mounted vacuum (suction) device in the Recovery Room of the hospital where the study was conducted. Readings were done at a variety of vacuums to show that the OEM is linear at different amounts of negative pressure. The OEM instrument mean was  $\bar{x} = 31.2$ , S.D. = 15.2 and the Ohio wall unit was  $\bar{x} = 31$ , S.D. = 16.6. There was a very high correlation,  $r = .99$ ,  $t_{(8)} = 45.92$ , and  $p < .001$ .

### Data Analysis

The principal analysis was analysis of covariance on each dependent variable. The analysis was implemented using multiple regression procedures because of unequal sample size in treatment groups, as well as advantages of multiple regression for identifying partial or conditional relationships among the covariates. Accepting or rejecting the hypothesis depended upon the results of these computations and their significance at the .05 level.

## CHAPTER IV

### RESULTS

#### Overview of Design

The purpose of this study was: To determine if a particular incisional splinting method utilized in the "stir-up" regimen for surgical patients contributed to more effective deep breathing and coughing. The findings are presented and discussed in relation to the research hypothesis which was: Hand and pillow methods of incisional splinting for postoperative deep breathing and coughing will not differ significantly in their effect on vital capacity and inspiratory pressure in cholecystectomized patients as measured by the Wright respirometer and the inspiratory force meter.

A three-step hierarchical multiple regression analysis was done separately for the vital capacity and inspiratory pressure measures. The first step of each analysis produced a regression equation for prediction of pretest level of the respiratory variables based upon the sex, age, weight, and smoking history of the patients. Step two of each analysis measures the extent to which variability in the first postoperative respiratory measures could be predicted from the surgical approach used

with the patient and the experimental treatment group to which he or she was assigned, over and above that which is predictable from pretest respiratory levels and pre-existing levels of the subject variables. Step three attempted to identify the extent to which day three respiratory measures could be predicted from surgical approach and treatment group and assignment beyond the level of predictability associated with preexisting conditions.

### Data Analysis

The mean vital capacity scores preoperatively and day one and three postoperatively for the control and experimental groups are presented in Table 1. The mean scores for males preoperatively in the control group were 3.51 L. and for the females 3.04 L.; for Group B (pillow group) males mean scores were 4.95 L. and females mean scores were 2.79 L.; for Group C (hands group), males mean scores were 3.83 L. and females mean scores were 2.39 L. Postoperatively, the mean scores for the males in Group A were 1.85 L., day one, and 2.10 L., day three; for the females 2.00 L., day one and 2.64 L. day three. Mean scores for the males in Group B were 2.90 L. day one and 3.07 L. day three; for the females, 1.74 L. day one and 2.27 L. day three. Males in Group C had mean scores of 1.68 L. day one and 1.73 L. day three; females had mean scores of 1.67 L. on day and 1.81 L. day three. Inspection

Table 1  
Means and Standard Deviations of Vital Capacity\* Scores  
Preoperatively and Day 1 and 3 Postoperatively  
for the Control and Experimental Groups

	Male			Female		
	Group A Control (N=5)	Group B Pillow (N=2)	Group C Hands (N=3)	Group A Control (N=10)	Group B Pillow (N=13)	Group C Hands (N=7)
Preoperative Vital Capacity						
Mean	3.51 L	4.95 L	3.83 L	3.04 L	2.79 L	2.39 L
S.D.	.89	1.41	.56	.60	.85	1.18
Day 1 (Postoperatively) Vital Capacity						
Mean	1.85 L	2.90 L	1.68 L	2.00 L	1.74 L	1.67 L
S.D.	1.27	1.27	.46	.55	.79	.76
Day 3 (Postoperatively) Vital Capacity						
Mean	2.10 L	3.07 L	1.73 L	2.64 L	2.27 L	1.81 L
S.D.	.33	2.15	.50	.31	.45	.98

\*Vital Capacity = Liters

of the means indicated that all groups experienced a decrease in vital capacity day one postoperatively with an increase by day three postoperatively.

Table 2 provides a summary of the mean inspiratory pressure scores preoperatively and day one and three postoperatively for the control and experimental groups. The mean scores for males preoperatively in the control group (Group A) were 34.4 mm. Hg. and for the females 33.8mm. Hg. For Group B (pillow group), the male mean scores were 30.0 mm. Hg. and female mean scores were 25.1 mm. Hg. Group C (hands group) males mean scores were 26.6 mm. Hg. and females mean scores were 20.0 mm. Hg. Postoperatively, the mean scores for males and females were: males (Group A) day one 11.8 mm. Hg. and females 20.1 mm. Hg.; males (Group B) day one were 30.0 mm. Hg. and females were 13.0 mm. Hg.; males (Group C) day one were 12.0 mm. Hg. and females were 17.7 mm. Hg. Mean inspiratory pressure scores for day three postoperatively were: males (Group A) 18.4 mm. Hg. and females 30.4 mm. Hg.; males (Group B) 16.0 mm. Hg. and females 27.0 mm. Hg.; males (Group C) 13.3 mm. Hg. and females 17.4 mm. Hg. Inspection of the means indicated that all groups showed a decrease in inspiratory pressure on day one postoperatively except the males in Group B (pillow). Males in Group B showed no increase by day three postoperatively. Females Group C (hands) also

Table 2

Means and Standard Deviations of Inspiratory Pressure\*

Scores Preoperatively and Day 1 and 3 Postoperatively

for the Control and Experimental Groups

	Male			Female		
	Group A Control (N=5)	Group B Pillow (N=2)	Group C Hands (N=3)	Group A Control (N=10)	Group B Pillow (N=13)	Group C Hands (N=7)
Preoperative Inspiratory Pressure						
Mean	34.4 mm.	30.0 mm.	26.6 mm.	33.8 mm.	25.1 mm.	20.0 mm.
S.D.	21.1	14.1	15.2	14.9	15.4	5.6
Day 1 (Postoperatively) Inspiratory Pressure						
Mean	11.8 mm.	30.0 mm.	12.0 mm.	20.1 mm.	13.0 mm.	17.7 mm.
S.D.	7.5	0.0	6.9	10.2	7.7	9.9
Day 3 (Postoperatively) Inspiratory Pressure						
Mean	18.4 mm.	16.0 mm.	13.3 mm.	30.4 mm.	27.0 mm.	17.4 mm.
S.D.	13.5	5.6	6.1	12.2	16.3	6.8

\*Inspiratory Pressure - mm. Hg.



showed no increase. The mean inspiratory scores for the remaining groups showed an increase by day three postoperatively.

Mean scores for age, weight and length of hospitalization for the control and experimental groups is summarized in Table 3. The mean age in the three groups ranged from 53 to 56.6 years for males and 46.1 to 49.6 years for the females. The mean weight ranged from 154 to 186.5 pounds for the males and 150.6 to 160.5 for the females. Length of hospitalization mean scores ranges from 9.0 to 10.5 days for the males and 7.11 to 10.10 days for the females.

An analysis was done to determine what preexisting variables might have an effect on inspiratory pressure and vital capacity. Table 4 provides a summary of pretest respiratory variability as a function of sex, age, weight, and smoking history. The R for inspiratory pressure was 0.30,  $F(4,35) = 0.84$ ,  $p > .50$ . Nothing related to inspiratory pressure. Vital capacity was found to be related to sex and age. There was a significant relationship ( $R = .60$ ,  $F[4,35] = 4.90$ ,  $p < .01$ ) between these variables (sex, age, weight and smoking) and baseline vital capacity preoperatively. Looking at the variables individually, the most important ones were sex ( $p < .01$ ) and age ( $p < .01$ ). The overall conclusion was that inspiratory pressure was

Table 3

Means and Standard Deviations of Age, Weight,  
and Length of Hospitalization for the Control  
and Experimental Groups

Group		Age*	Weight*	Hospitalization*
<u>Group A</u>				
<u>Control</u>				
Male (N=5)	Mean	56.6	164.0	9.80
	S.D.	16.5	44.8	2.05
Female (N=10)	Mean	49.6	159.3	7.11
	S.D.	16.5	33.9	2.26
<u>Group B</u>				
<u>Pillow</u>				
Male (N=2)	Mean	53.0	186.5	10.50
	S.D.	26.8	19.1	7.78
Female (N=13)	Mean	47.9	160.5	10.10
	S.D.	19.7	40.0	4.41
<u>Group C</u>				
<u>Hands</u>				
Male (N=3)	Mean	55.0	154.0	9.00
	S.D.	12.1	21.0	5.20
Female (N=7)	Mean	46.1	150.6	8.00
	S.D.	25.7	15.0	3.42

\*Age = years

Weight = pounds

Hospitalization = days in hospital

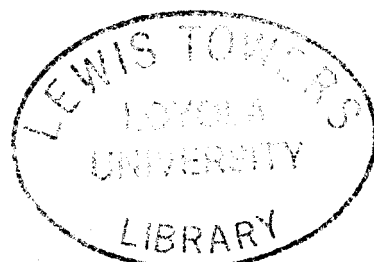


Table 4  
Multiple Regression Analysis of Pre-Test  
Respiratory Variability as a Function of  
Sex, Age, Weight and Smoking History

Variable	Regression Weight	F (1,35)	P
Inspiratory Pressure			
Sex	- .15	0.79	> .50
Age	- .21	1.32	> .25
Weight	0.20	1.55	> .10
Smoking	-0.03	0.03	> .50
R=0.30, F(4,35)=0.84 p>.50			
Vital Capacity			
Sex	- .55	15.79	< .01
Age	- .39	6.59	< .01
Weight	- .03	0.06	> .50
Smoking	- .09	0.35	> .50
R=.60, F(4,35)=4.90, p<.01			

not related to preexisting conditions. Vital capacity was related to preexisting conditions and the important conditions were age and sex of patient.

A summary of variability in respiratory responses on day one postoperatively is presented in Table 5. Pre-existing conditions (sex, age, weight, smoking history, and pretest vital capacity) were important in predicting vital capacity ( $F = 3.66$ ,  $df = 5/34$ ,  $p < .02$ ) day one postoperatively. Included in these preexisting conditions was the pretest vital capacity which showed that postoperative vital capacity could be predicted from preoperative vital capacity and these other preexisting conditions ( $p < .02$ ). This finding demonstrates the importance of being aware of vital capacity preoperatively before any conclusions can be made about vital capacity postoperatively. These findings indicate that there is a relationship between pre- and postoperative conditions. There is predictability ( $p < .02$ ) for day one postoperative vital capacity in pre-existing conditions.

Secondly, surgical approach was added to the predictions. The  $R^2$  change (.026,  $F = .067$ ,  $df = 2/32$ ) was not significant ( $p > .50$ ). Removing the variance of vital capacity and the first step resulted in statistical removal of all the variability due to preexisting conditions. Any remaining variability would be due to a significant treat-

Table 5  
Multiple Regression Analysis of Variability in  
Respiratory Responses on Day One

	R	R <sup>2</sup> Change	F	df	P
Vital Capacity					
Pre-existing* Conditions	.588		3.66	5/34	< .02
Surgical Approach	.610	.026	.67	2/32	> .50
Treatment Groups	.612	.003	.07	2/30	> .50
Inspiratory Pressure					
Pre-existing* Conditions	.408		1.36	5/34	> .25
Surgical Approach	.492	.075	1.58	2/32	> .10
Treatment Groups	.512	.020	0.42	2/30	> .50

\*(Sex, age, weight, smoking history, and pre-test inspiratory pressure or vital capacity.)

ment effect or error. The amount of variability ( $R^2$  change = .003,  $F = 0.07$ ,  $df = 2/30$ ) in vital capacity that treatment groups themselves accounted for was not significant ( $p > .50$ ). The amount of variability ( $R^2$  change .020,  $F = 0.42$ ,  $df = 2/30$ ) in inspiratory pressure that treatment groups accounted for was not significant ( $p > .50$ ). This analysis was a direct test of the research hypothesis, controlling for the other effects statistically as opposed to mechanically. These findings support the research hypothesis.

Table 6 provides a summary of the variability in respiratory responses on day three. Vital capacity and inspiratory pressure were found to have strong prediction for preexisting condition: vital capacity ( $p < .01$ ); inspiratory pressure ( $p < .01$ ). The situation day three is strongly related to the situation in day one. Comparing Tables 5 and 6, the  $R$ 's in both cases for preexisting conditions have greatly increased: day one postoperatively preexisting conditions for vital capacity ( $R = .588$ ), day three ( $R = .710$ ); day one postoperatively preexisting conditions for inspiratory pressure ( $R = .408$ ), day three ( $R = .716$ ). This finding indicated that there was a much stronger predictability based on preexisting conditions on day three than on day one and major change in preexisting conditions day one level.

Table 6  
Multiple Regression Analysis of Variability in  
Respiratory Responses on Day Three

	R	R <sup>2</sup> Change	F	df	P
Vital Capacity					
Pre-existing* Conditions	.710		5.59	6/33	< .01
Surgical Approach	.717	.010	0.32	2/31	> .50
Treatment Groups	.756	.057	1.94	2/29	> .10
Inspiratory Pressure					
Pre-existing* Conditions	.716		5.79	6/33	< .01
Surgical Approach	.720	.017	0.17	2/31	> .50
Treatment Groups	.743	.033	1.09	2/29	> .25

\*(Sex, age, weight, smoking history, pre-test and day one inspiratory pressure or vital capacity.)

The analysis was done this way because there could have been an effect of group on day three that was not there on day one. The data was analyzed separately to determine if there was an effect on the third day that was not there on the first day. If treatments were going to have an effect (if the method of splinting made a difference) one might not expect to see a difference on the first day. However, by the third day, such a change should be obvious. The difference might be seen by the third day even though the first day the splinting really had not had a chance to have any effect at all. Patients might be hesitant to do any splinting on the first day. The analysis showed, however, that on the third day, there was no significant change in the vital capacity ( $p > .10$ ) or inspiratory pressure ( $p > .25$ ). The vital capacity came close with a slight tendency approaching 10 percent, suggesting research might be replicated some other time, and there might be a relationship that is worth reexamining.

Age-adjusted variance in vital capacity as a function of sex, treatment group, and time of measurement is summarized in Table 7. The course of respiratory response across the three days is presented (specifically the precipitous drop postoperatively with recovery). Between Subjects, Groups (G) are significant ( $df = 2$ ,  $F = 3.88$ ,  $p < .05$ ) but the significance is overall (if every subject



Table 7

Least Squares Analysis of Age-Adjusted Variance in  
 Vital Capacity as a Function of Sex, Treatment  
 Group, and Time of Measurement

Source of Variance	SS Adj.	df	F	P
Between Subjects		38		
Groups (G)	670.1	2	3.88	< .05
Sex (S)	928.9	1	10.77	< .01
G by S	687.2	2	3.98	< .05
Subjects within Groups	2,847.5	33		
Within Subjects		80		
Time (T)	3,099.1	2	48.81	< .01
T by G	62.75	4	0.49	> .50
T by S	615.6	2	9.69	< .01
T by G by S	437.0	4	0.34	> .50
T by Subjects	2,158.8	68		

were given his total score for vital capacity and inspiratory pressure). The fact that these measurements were taken at different times has been covaried. If the groups differed as a function of treatment of specific days, an interaction with time of measurement would be expected. Time by Group (T by G) interaction was not significant ( $p > .50$ ). The observed difference in groups between subjects was a difference between groups that occurred on the pretest (pre-existing differences among the groups) as well as the posttest. Vital capacity was unrelated to actual treatment group because the interaction by time of measurement (T by G by S) was not significant ( $p > .50$ ). Those differences existed on the pretest as well. In these comparisons, two high means for the males were based on very small sample sizes (Hands,  $\bar{X} = 2.49$  L.,  $N = 3$  and Pillow,  $\bar{X} = 3.69$ ,  $N = 2$ ). This finding points to the possibility of accidental differences. The Time by Group by Sex (T by G by S) analysis showed that it was not produced by post-surgical behavior ( $p > .50$ ). The groups did differ according to overall responses, and there was an overall sex difference as well. The sex difference was interpretable while actual group difference was an accidental difference.

The Within Subjects analysis shows a significant time measurement ( $p < .01$ ) among the levels. There was also a significant ( $p < .01$ ) interaction of time with sex.

Cell means for the sex by time of measurement interaction in Table 7 is provided in Figure 1. This figure shows the time significance compared to preoperative levels of vital capacity, the reduction day one postoperatively, and gradual improvement day three postoperatively. The interaction with sex shows males vital capacity decreased much further than the females with substantially less recovery by day three. Table 8 provides cell means of vital capacity for the sex by group interaction from Table 7. This data illustrates that the groups were different. The control group had an average vital capacity of 2.57 L., the hands group had an average of 2.20 L., and the pillow group had an average of 2.96 L. Overall, these groups did have different totals. Sex difference was highly significant ( $p < .01$ ). Males had greater vital capacities than females. There was a Group by Sex (G by S) interaction which indicated a difference in sex with the hands group, a difference in sex with the pillow group, but less of a difference with the control group.

The meaningful results of these analyses were a type of measurement and time interacting with subjects. These are analyses of covariance because the subjects were adjusted for age, necessary due to its relationship to sex (males approximately six years older than females). An adjustment was made to make certain that an effect was not

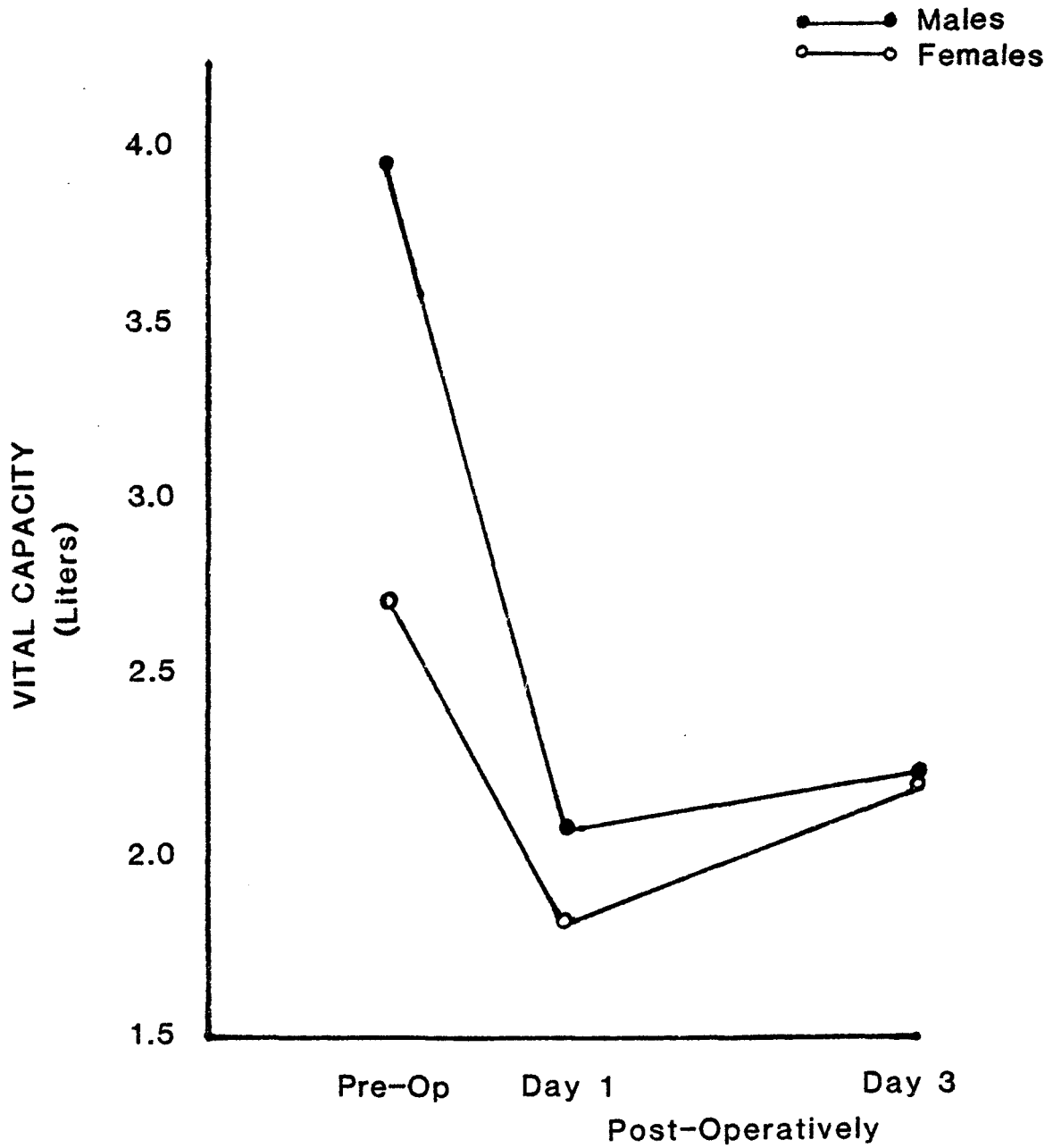


Fig. 1. Cell means for the sex by time of measurement interaction in Table 7.

Table 8  
 Cell Means of Vital Capacity\* for  
 the Sex by Group Interaction  
 from Table 7

	Treatment Group		
	Control	Hands	Pillow
Male	2.59 (N=5)	2.49 (N=3)	3.69 (N=2)
Female	2.56 (N=10)	1.90 (N=7)	2.24 (N=13)

\*Measured in liters.

attributable to age. Nothing from this analysis could be explained by an age difference.

Table 9 provides a summary of variance in age-adjusted inspiratory pressure as a function of sex, treatment group, and time of measurement. No Between Subjects effects were seen. Within Subjects, there was a significant ( $p < .01$ ) time effect, and there was a marginally significant ( $p < .10$ ) Time by Sex (T by S) effect. Cell means for sex by time of measurement interaction in Table 9 is presented in Figure 2. This figure shows that inspiratory pressure was greatly reduced on postoperative day one with the drop for males and females about the same. Recovery (day three) appeared to suggest that females recovered more quickly than males.

A path analytic representation of the relationship among anesthetic duration, vital capacity, and length of hospitalization is provided in Table 10. This analysis was a method attempting to identify causal flow of undecided variables. The variables had to exist in some kind of logical order which is defined by necessary pre-existing conditions or time flow. The anesthetic (D) occurred before vital capacity (VC) measurement on day one postoperatively. There is a logical order of D (duration of anesthetic), VC (vital capacity, day one postoperatively), and H (hospitalization). Vital capacity (VC) was measured day one postoperatively. It is known that vital capacity

Table 9

Least Squares Analysis of Variance in Age-Adjusted  
 Inspiratory Pressure as a Function of Sex,  
 Treatment Group and Time of Measurement

Source of Variance	SS Adj.	df	F	P
Between Subjects		37		
Group (G)	866.4	2	1.43	> .25
Sex (S)	116.0	1	0.38	> .50
G by S	128.9	2	0.21	> .50
Subjects within Groups	9,670.8	32		
Within Subjects		78		
Time (T)	893.7	2	5.62	< .01
T by G	558.6	4	1.76	> .10
T by S	408.3	2	2.57	< .10
T by G by S	539.6	4	1.70	> .10
T by Subjects	5,250.5	66		

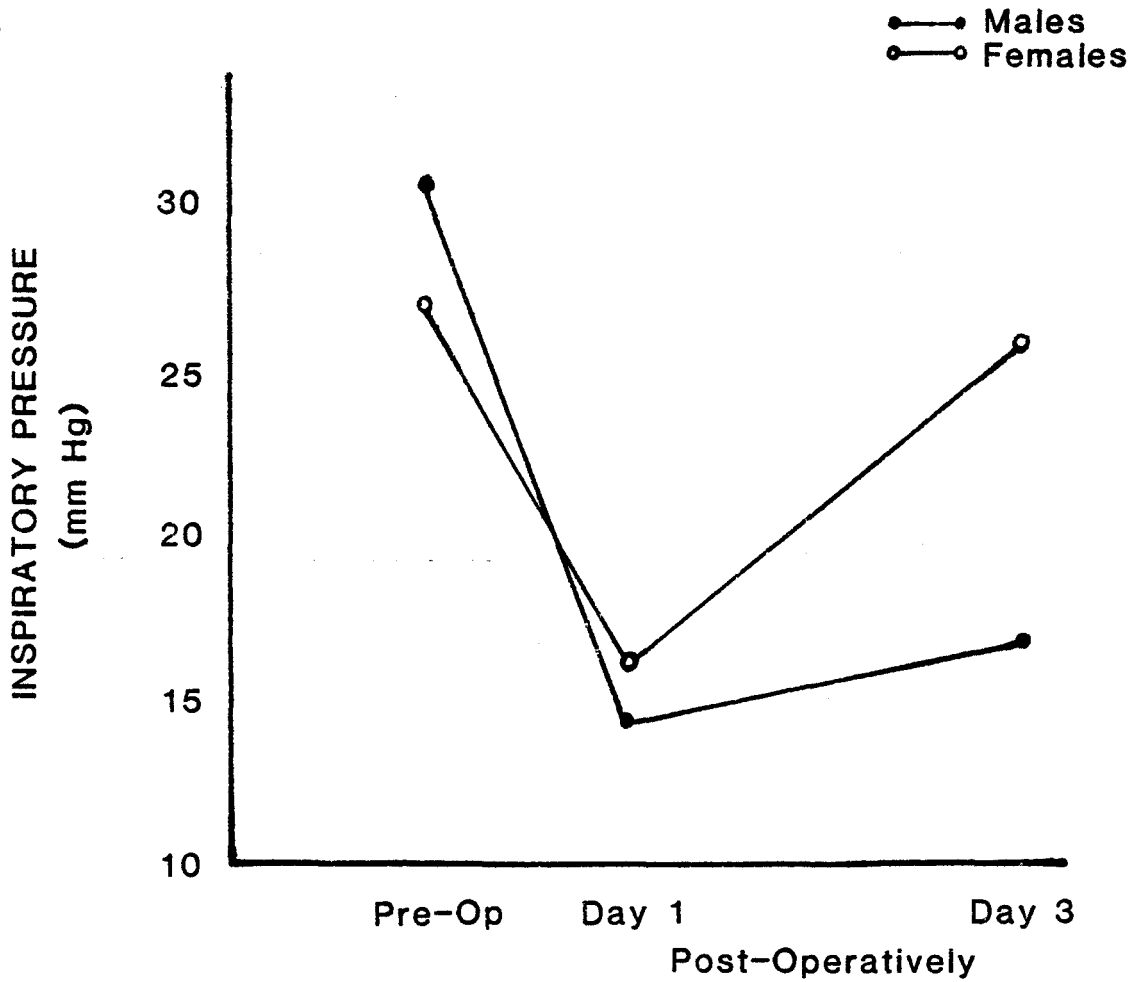
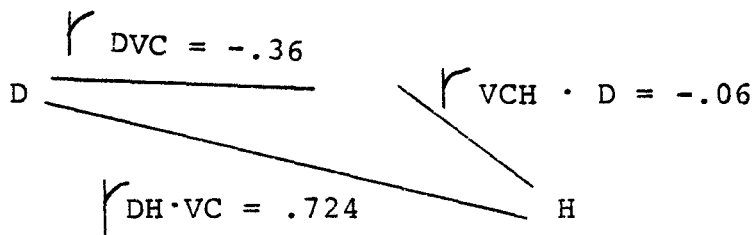


Fig. 2. Cell means for the sex by time of measurement interaction in Table 9.



Table 10  
 Path Analytic Representation of the Relationship  
 Among Anesthetic Duration, Vital Capacity, and  
 Length of Hospitalization



$r_{DVC} = -.36$	$r_{VCH} = -.33$	$r_{DH} = .76$
$F(1,38) = 5.50$	$F(1,38) = 4.64$	$F(1,38) = 7.21$
$p < .01$	$p < .01$	$p < .01$

D = duration of anesthetic  
 VC = vital capacity (day one postoperatively)  
 H = length of hospitalization

is a variable that is strongly affected by surgery.

Path analysis makes use of all the individual correlations. There was a significant correlation between duration of anesthetic (D) and vital capacity (VC),  $r_{DVC} = -.36$ ,  $F(1,38) = 5.50$ ,  $p < .01$ . This negative correlation ( $-.36$ ) meant the longer the anesthetic, the lower the vital capacity (day one). Anesthetic is related to vital capacity. Was vital capacity related to length of hospitalization? There was a significant ( $r_{VCH} = -.33$ ,  $F(1,38) = 4.64$ ,  $p < .01$ ) relationship between decrease in vital capacity and increased length of hospitalization. Length of anesthetic was related directly to length of hospitalization. Does the anesthetic itself predict hospitalization over and above the decrease in vital capacity? Vital capacity (DVC) could be predicted quite well. From vital capacity to hospitalization (VCH), there was a direct relationship ( $r_{VCH} = -.33$ ). This could have been due to the fact that vital capacity day one postoperatively predicts length of hospitalization or to the extent that the duration of anesthetic predicts vital capacity and also predicts hospitalization. The reason there is a path relationship is because something else predicts them both. This is the correlation between vital capacity and length of hospitalization, holding duration of anesthetic constant ( $r_{VCH \cdot D} = -.06$ ).

Finally, the question was asked, how much does duration of anesthetic predict hospitalization directly over and above the way duration of anesthetic is related to postoperative vital capacity? The relationship  $DH \cdot VC$  examined only patients whose vital capacity is the average of the subjects in this study. Looking at the duration of anesthetic, length of hospitalization could very well be predicted ( $r_{DH \cdot VC} = .724$ ) even though all had the same level of postoperative vital capacity.

There was a strong relationship between duration of anesthetic and decrease in vital capacity postoperatively. Further, people who were under an anesthetic a long time clearly stayed in the hospital longer. The extent of the decrease in postoperative vital capacity produced by the anesthetic was not predictive of hospitalization over and above what was predicted from the length of the anesthetic itself. This finding suggests that anesthesia appears to have some relationship to hospitalization over and above the way it relates to postoperative vital capacity.

## CHAPTER V

### DISCUSSION

#### Conclusions

No statistically significant results were found among the control and the two experimental groups. The research hypothesis predicting that hand and pillow methods of incisional splinting for postoperative deep breathing and coughing will not differ significantly in their effect on vital capacity and inspiratory pressure in cholecystomized patients as measured by the Wright respirometer and the inspiratory force meter was accepted.

This finding suggests to the nurse that the method of incisional splinting is optional. A structured pre-operative teaching program could, therefore, include a variety of alternatives. Such a program might reassure the patient that any method of incisional splinting he may prefer will probably be as beneficial as any other. As pointed out by Carrieri (1975), on the basis of the findings of a study by Fink (1967), the patient's ability to engage in active participation and decision making during the first 72 hours postoperatively seems questionable. Nursing actions necessary to improve patients' lung function after surgery must be performed frequently, without

interruption throughout all hours of the postoperative period, and these actions must be accompanied by instruction and help for the patient (components which were not included in this study). Health team members should not expect the patients to perform deep breathing and coughing without assistance while they are acutely ill and experiencing postoperative pain. Perhaps the fact that there was not a structured preoperative teaching program regarding a specific splinting technique followed by frequent reinforcement and help with the maneuver may account partially for the lack of significant difference between incisional splinting methods.

The focus of this study was an examination of the mechanics of postoperative ventilatory capacity (as measured by vital capacity and inspiratory pressure) and ways to improve the mechanics. Shapiro (1980) states that a vital capacity in excess of 15 ml./kg. should transiently provide an adequate postoperative ventilatory reserve and allow for adequate deep breathing and coughing. The observation that vital capacity is reduced 50-75 percent within 24 hours following thoracic or abdominal surgery was first reported in 1927. This observation has been reconfirmed numerous times and has proven to be extremely consistent. Since the normal adult vital capacity ranges between 55 and 85 ml./kg. of normal body weight, any acute decrease in vital capacity of up to 75 percent would leave

most individuals with a vital capacity of at least 15 ml./kg.

The postoperative vital capacity reduction occurs gradually over 12-18 hours following the surgical procedure. Therefore, the patient's ventilatory reserves will usually be significantly less 12 hours postoperatively than immediately following the surgical procedure. A clinical axiom of respiratory evaluation in the post-surgical patient is: the vital capacity is maximally reduced 12-18 hours postoperatively and then gradually improves unless complications intervene. Most patients with an uncomplicated course approach their preoperative vital capacities by the third or fourth postoperative day. Most patients survive the acute restrictive pulmonary insult of elective thoracic and abdominal surgery with few detectable clinical problems (Shapiro, 1980).

This finding suggests that patients with normal lungs recover naturally from the drastic reduction in vital capacity which occurs 24 hours postoperatively. This study supported the fact that patients' vital capacity drops precipitously within 24 hours and then gradually returns to normal. There was no structured preoperative teaching program in the hospital where the study was conducted. The need for intensive and aggressive nursing involvement may not be as critical in patients with normal lungs as it may be with the high risk patient, patients with preexisting

lung disease. Although all presurgical patients should have benefit of instruction in the "stir-up" regimen, special attention should be focused on the patient with abnormal pulmonary function studies preoperatively. This study pointed to the importance of preoperative pulmonary screening (especially vital capacity) as predictors of postoperative ventilatory capacity. This is consistent with several recent studies (Yoshida, 1977; Levy, Rutherford, & Shepard, 1979; and Peters, 1979) which suggest that pulmonary screening tests can be used to evaluate the risk of pulmonary complications developing in the postoperative period. Spirometry was shown to be equally as useful as chest x-ray in improving the accuracy and efficiency of screening procedures. With proper instruction, the nurse could be involved with spirometric evaluation of presurgical patients.

Although the female subjects in this study had lower vital capacities initially, postoperatively the decrease was less and recovery toward normal was faster. Studies in the past (Kurzweg, 1953) indicated that postoperative pulmonary complications are far more frequent in men than in women. The explanation is physiologic: Male respiration is diaphragmatic and abdominal while female respiration is costal, which means that men are more likely to be disturbed by abdominal surgery, particularly upper abdominal, than are women. A second reason for the male

predominance is related to the first, normal respiration is reestablished more promptly after operation in women than in men.

This study showed a significant relationship between duration of anesthesia and length of hospitalization. Although not clearly documented, it appears that any general anesthetic regimen properly administered and monitored will not, in and of itself, contribute to postoperative pulmonary complication. However, procedures exceeding three hours appear to be associated with higher incidence of postoperative pulmonary complications (Shapiro, 1980). The nurse needs to be aware of the significance of the anesthetic experience and its possible contribution to postoperative complications (including length of hospitalization).

### Recommendations

It is suggested that the study be repeated including a structured preoperative teaching program regarding a specific splinting technique with frequent reinforcement by the nurse.

Another recommendation would be replication of this study using patients with documented chronic obstructive lung disease. Such a study might yield information as to whether patients at higher risk would benefit from a particular splinting technique.



A study comparing splinting technique in patients having regional anesthesia is suggested. Shapiro (1980) has proposed that regional anesthesia does not appear to diminish postoperative pulmonary complication but may play a role if utilized for postoperative pain relief.

It is recommended that a larger array of pulmonary function tests be utilized to give a more comprehensive picture of the patient's respiratory status. Elimination of the inspiratory pressure tool is suggested because of certain patient's tendencies to suck on the mouthpiece, thereby creating false high (intraoral) negative inspiratory pressures.\* Another approach might be to use a wider bore mouthpiece to make sucking less of a problem.

Finally, it is suggested that the study be repeated using a larger sample and possibly including other upper abdominal procedures which would allow for more male subjects. Later postoperative follow-up, such as measurement of ventilatory capacity on day of discharge, is recommended to see if the trend toward normal vital capacity continues. Although planned for this study, it proved technically too difficult. It was often impossible for the investigator to be at the hospital on day of discharge.

Evaluation and management of respiratory function

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\*Two males were deleted from the study because of their unreasonably high scores due to sucking.

in the perioperative period is an area requiring much further nursing research. The answers are far from clear.

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## APPENDIX A

CONTENT OF PREOPERATIVE INSTRUCTION  
FOR CONTROL GROUP

1. My name is Kay Fraulini. I am a registered nurse working on my master's degree, and I am conducting a study on deep breathing and coughing postoperation. You will probably be asked to cough and deep breathe by the other nurses you come into contact with. It is an important part of your recovery after surgery and anesthesia. I have an informed consent for you to read and sign if you are interested in participating in this study.

2. I would like for you to sit on the side of your bed so that I can measure your breathing capacity with this small gauge. It is painless and requires only that you take as deep a breath as possible and then blow it all out. This is done best with this padded noseclip in place. Secondly, using a similar gauge, I would like you to breathe as deeply as possible, I will remove the mouthpiece, and you can exhale. We can go through a trial run, if you like (to get a feel for the mouthpiece and noseclip).

I would like to repeat these tests tomorrow, two days after that and the day you go home.

If you can, try and remember how many times during the day you have done your deep breathing and coughing. When I visit you after surgery, I will ask you to attempt

to recall how many times or how often you did the exercises that day.

## APPENDIX B

CONTENT OF PREOPERATIVE INSTRUCTION  
FOR EXPERIMENTAL GROUPS

1. My name is Kay Fraulini. I am a registered nurse working on my master's degree. I am conducting a study on deep breathing and coughing postoperation. You will probably be asked to deep breathe and cough by the other nurses you come in contact with. It is an important part of your recovery after surgery and anesthesia. When you deep breathe and cough, I would like to request that you place a pillow/hands over your incision. This may offer some support which will make the exercise easier. I have an informed consent for you to read and sign if you are interested in participating in this study.

2. I would like for you to sit on the side of your bed and place pillow/hands over your incision so that I can measure your breathing capacity with this small gauge. It is painless and requires only that you take as deep a breath as possible and then blow it all out. This is done best with this padded noseclip in place. Secondly, using a similar gauge, I would like you to breathe as deeply as possible, I will remove the mouthpiece, and you can exhale. We can go through a trial run, if you like (to get a feel for the mouthpiece and noseclip).

I would like to repeat thses tests tomorrow, two days after that, and then the day you go home.

If you can, try and remember how many times during the day you have done your deep breathing and coughing (with pillow/hands in place). When I visit you after surgery, I will ask you to attempt to recall how many times, or how often you did the exercises that day.

## APPENDIX C

# PATIENT CHECKLIST

Patient

Group: A B C

Age

Sex

Weight

Surgical approach

General anesthesia: Type

## DURATION

Smoking history

Last analgesic

Respiratory rate

Temperature

Pain: report of before "stir-up"

request for meds after "stir-up"

Length of hospitalization

## SPIROMETRY

Vital Capacity (ml)	Inspiratory Pressure mm. Hg.
Preop	
Day 1	
Day 3	
Discharge	

Number of times patient reports doing "stir-up"

Day 1	3	Discharge
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## APPENDIX D

## INFORMED CONSENT

Patient's Name: \_\_\_\_\_ Date: \_\_\_\_\_

TITLE: Incisional Splinting Techniques in Postoperative  
Coughing

### Patient Information

#### INFORMED CONSENT

This study is being conducted to determine the value of splinting a postoperative incision to produce a more effective deep breath and cough. The benefit of this activity for you is that it tends to prevent and/or reduce postoperative problems. A potential benefit may be a decrease in the length of time you are in the hospital.

These activities have been taught and performed by patients for the past twenty-five years or more. There have been no known risks for you to cough and deep breathe. Splinting your incision with a pillow or your hands may reduce some of the discomfort you may experience in coughing and deep breathing.

In your preoperative workup, a registered nurse will come to your room and test your breathing capacity. The same breathing test will be done by the nurse in your room within twenty-four and then again seventy-two hours after surgery. A soft padded clip will be placed on your nose and a mouth piece will be placed in your mouth. This procedure takes about three to five minutes and will be explained to you by the nurse. There is very little discomfort and no known risks to you. There will be no charge for these preoperative and postoperative tests.

The registered nurse who visits you will answer your questions about the activities.

## APPENDIX E

## INFORMED CONSENT

Patient's Name: \_\_\_\_\_ Date: \_\_\_\_\_

TITLE: Incisional Splinting Techniques in Postoperative  
Coughing

### Patient Information

#### INFORMED CONSENT

This study is being conducted to determine the value of techniques to produce more effective cough and deep breathing postoperatively. You will receive the usual preoperative instruction from the nurses assigned to give nursing care to you. This study will not benefit you directly during this hospitalization. However, it will help nurses design a plan for teaching you and other patients in the future.

In your preoperative workup, a registered nurse will come to your room and test your breathing capacity. The same breathing test will be done by the nurse in your room within twenty-four and then again seventy-two hours after surgery. A soft padded clip will be placed on your nose and a mouthpiece will be placed in your mouth. This procedure takes about three to five minutes and will be explained to you by the nurse. There is very little discomfort and no known risks to you. There will be no charge for these preoperative and postoperative tests.

The registered nurse who visits you will answer your questions about the activities.

## APPENDIX F

### PATIENT CONSENT FORM

I have been informed in writing of the research project of Ms. Kay E. Fraulini for completion of her Master's Thesis in Nursing at Loyola University of Chicago. I understand that she will need to consult my chart in order to confirm:

- a) Age
- b) Weight
- c) Type and duration of general anesthesia
- d) Smoking history
- e) Last pain medication
- f) Respiratory rate
- g) Length of hospitalization

I have reviewed Dr. Imre Illes's letter of sponsorship and understand that any information gathered will be held in strict confidentiality. I understand that my involvement will consist of a breathing test done the night before surgery and on the first and third days after operation and the day of discharge. It is my understanding that I may unilaterally withdraw from participation at any time and that such withdrawal will not infringe upon my care in any manner. With this understanding, I am willing to participate in this project. My physician has been informed of this.

I have received a signed copy of this form for my records.

\_\_\_\_\_  
Signature of Patient

\_\_\_\_\_  
Signature of Witness

\_\_\_\_\_  
Printed Name of Patient

\_\_\_\_\_  
Printed Name of Witness

\_\_\_\_\_  
Date

\_\_\_\_\_  
Date

### STATEMENT OF CONFIDENTIALITY

This study is being conducted for completion of a thesis for a Master of Science Degree in Nursing at Loyola University of Chicago. Any information gathered in this study will be held as confidential.

\_\_\_\_\_  
Ms. Kay E. Fraulini, B.S.N., R.N.  
Graduate student, Loyola University  
of Chicago

\_\_\_\_\_  
Date

## APPENDIX G

PHYSICIAN CONSENT FORM

I have been informed of the research project of Ms. Kay E. Fraulini for completion of her Master's Thesis in Nursing at Loyola University of Chicago. I am aware of the purposes for data collection and have approved the use of spirometry and the patient consent form. This form is to signify that those patients of mine who comply with guidelines of the study may participate in Ms. Fraulini's project.

\_\_\_\_\_  
Physician Signature

\_\_\_\_\_  
Date



APPROVAL SHEET

The thesis submitted by Kay Etta Fraulini has been read and approved by the following committee:

Dr. Betty Tarsitano, Director  
Assistant Professor, Nursing, Loyola

Dr. Linda W. Janusek  
Assistant Professor, Nursing, Loyola

Dr. Marilyn Bunt  
Assistant Professor, Nursing, Loyola

The final copies have been examined by the director of the thesis and the signature which appears below verifies the fact that any necessary changes have been incorporated and that the thesis is now given final approval by the Committee with reference to content and form.

The thesis is therefore accepted in partial fulfillment of the requirements for the degree of Master of Science in Nursing.

\_\_\_\_\_  
Date

\_\_\_\_\_  
Director's Signature

## INFORMED CONSENT

Patient's Name: \_\_\_\_\_ Date: \_\_\_\_\_

TITLE: Incisional Splinting Techniques in Postoperative Coughing

### Patient Information

#### INFORMED CONSENT

This study is being conducted to determine the value of techniques to produce more effective cough and deep breathing postoperatively. You will receive the usual preoperative instruction from the nurses assigned to give nursing care to you. This study will not benefit you directly during this hospitalization. However, it will help nurses design a plan for teaching you and other patients in the future.

In your preoperative workup, a registered nurse will come to your room and test your breathing capacity. The same breathing test will be done by the nurse in your room within twenty-four and then again seventy-two hours after surgery. A soft padded clip will be placed on your nose and a mouthpiece will be placed in your mouth. This procedure takes about three to five minutes and will be explained to you by the nurse. There is very little discomfort and no known risks to you. There will be no charge for these preoperative and postoperative tests.

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- a) Age
- b) Weight
- c) Type and duration of general anesthesia
- d) Smoking history
- e) Last pain medication
- f) Respiratory rate
- g) Length of hospitalization

I have reviewed Dr. Imre Illes's letter of sponsorship and understand that any information gathered will be held in strict confidentiality. I understand that my involvement will consist of a breathing test done the night before surgery and on the first and third days after operation and the day of discharge. It is my understanding that I may unilaterally withdraw from participation at any time and that such withdrawal will not infringe upon my care in any manner. With this understanding, I am willing to participate in this project. My physician has been informed of this.

I have received a signed copy of this form for my records.

\_\_\_\_\_  
Signature of Patient

\_\_\_\_\_  
Signature of Witness

\_\_\_\_\_  
Printed Name of Patient

\_\_\_\_\_  
Printed Name of Witness

\_\_\_\_\_  
Date

\_\_\_\_\_  
Date

### STATEMENT OF CONFIDENTIALITY

This study is being conducted for completion of a thesis for a Master of Science Degree in Nursing at Loyola University of Chicago. Any information gathered in this study will be held as confidential.

\_\_\_\_\_  
Ms. Kay E. Fraulini, B.S.N., R.N.  
Graduate student, Loyola University  
of Chicago

\_\_\_\_\_  
Date

APPENDIX G

PHYSICIAN CONSENT FORM

I have been informed of the research project of Ms. Kay E. Fraulini for completion of her Master's Thesis in Nursing at Loyola University of Chicago. I am aware of the purposes for data collection and have approved the use of spirometry and the patient consent form. This form is to signify that those patients of mine who comply with guidelines of the study may participate in Ms. Fraulini's project.

\_\_\_\_\_  
Physician Signature

\_\_\_\_\_  
Date

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The thesis is therefore accepted in partial fulfillment of the requirements for the degree of Master of Science in Nursing.

12/12/80  
Date

Betty J. Tarsitano  
Director's Signature